

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application. Please cancel Claims 1-10 and 46-48 without prejudice. Please amend Claims 11-45. Please add new Claims 49-59.

Listing of Claims

Claims 1 – 10 (Canceled).

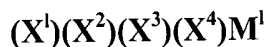
11. (Currently Amended) A process to produce a catalyst composition;
~~said process~~ comprising:

↳ contacting ~~said~~ a catalyst precursor ~~of Claim 9~~ with at least one organometal compound and at least one organoaluminum compound;

wherein the catalyst precursor comprises at least one treated solid oxide compound and at least one alpha olefin;

wherein the at least one treated solid oxide comprises a contact product of at least one solid oxide compound, at least one electron-withdrawing anion source compound, and optionally, at least one metal salt compound;

wherein ~~said~~ the organometal compound has the following general formula:



wherein M^I is selected from ~~the group consisting of~~ titanium, zirconium, ~~and or~~ hafnium;

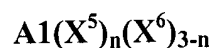
wherein (X¹) and (X²) are independently selected from ~~the group consisting of~~ cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, ~~and or~~ substituted fluorenyls;

wherein substituents on ~~said the~~ substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X¹) and (X²) are selected from ~~the group consisting of~~ aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, ~~and or~~ hydrogen;

wherein at least one substituent on (X¹) and (X²) is a bridging group which connects (X¹) and (X²);

wherein (X³) and (X⁴) are independently selected from ~~the group consisting of~~ halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxide groups, substituted alkyloxide groups, aryloxide groups, substituted aryloxide groups, organometallic groups, ~~and or~~ substituted organometallic groups; and

wherein ~~said the~~ organoaluminum compound has the following general formula:



wherein (X⁵) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X^6) is a halide, hydride, or alkoxide; and

wherein “n” is a number from 1 to 3 inclusive.

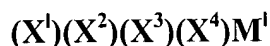
12. (Currently Amended) A process to produce a catalyst composition;
~~said process~~ comprising:

1-) contacting ~~said~~ a catalyst precursor ~~of Claim 10~~ comprising a chlorided, zinc-containing alumina and propylene with at least one organometal compound selected from ~~the group consisting of~~ rac-dimethylsilybis (1-indenyl) zirconium dichloride, rac-1,2-ethanediylbis(1-indenyl)zirconium dichloride, or rac-dimethylsilybis (2-methyl-1-indenyl) zirconium dichloride and at least one organoaluminum compound selected from ~~the group consisting of~~ triethylaluminum ~~and~~ or triisobutylaluminum.

13. (Currently Amended) A process for producing a catalyst composition;
~~said process~~ comprising simultaneously contacting at least one treated solid oxide compound, at least one organometal compound, at least one organoaluminum compound, and at least one alpha olefin;

wherein ~~said~~ the treated solid oxide compound is produced by a process comprising: a) contacting at least one solid oxide compound with at least one electron-withdrawing anion source compound; b) optionally, also contacting ~~said~~ the solid oxide compound with at least one metal salt compound; and c) calcining ~~said~~ the solid oxide compound before, during, or after contacting ~~said~~ the electron-withdrawing anion source compound or ~~said~~ the metal salt compound to produce ~~said~~ the treated solid oxide compound;

wherein ~~said~~ the organometal compound has the following general formula:



wherein M^1 is selected from ~~the group consisting of~~ titanium, zirconium, and or hafnium;

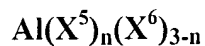
wherein (X^1) and (X^2) are independently selected from ~~the group consisting of~~ cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, and or substituted fluorenyls;

wherein substituents on ~~said~~ the substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X^1) and (X^2) are selected from ~~the group consisting of~~ aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, and or hydrogen;

wherein at least one substituent on (X^1) and (X^2) is a bridging group which connects (X^1) and (X^2) ;

wherein (X^3) and (X^4) are independently selected from ~~the group consisting of~~ halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxy groups, substituted alkyloxy groups, aryloxy groups, substituted aryloxy groups, organometallic groups, and or substituted organometallic groups; and

wherein ~~said~~ the organoaluminum compound has the following general formula:



wherein (X^5) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X^6) is a halide, hydride, or alkoxide; and

wherein "n" is a number from 1 to 3 inclusive.

14. (Currently Amended) A process for producing a catalyst composition; ~~said process~~ comprising simultaneously contacting a chlorided, zinc-containing alumina; propylene; at least one organometal compound selected from ~~the group consisting of~~ rac-dimethylsilybis (1-indenyl) zirconium dichloride, rac-1,2-ethanediylbis (1-indenyl) zirconium dichloride, or rac-dimethylsilybis (2-methyl-1-indenyl) zirconium dichloride; and at least one organoaluminum compound selected from ~~the group consisting of~~ triethylaluminum and triisobutylaluminum.

15. (Currently Amended) A catalyst composition ~~produced by the process of Claim 11~~ comprising a contact product of a catalyst precursor with at least one organometal compound and at least one organoaluminum compound;

wherein the catalyst precursor comprises at least one treated solid oxide compound and at least one alpha olefin;

wherein the at least one treated solid oxide comprises a contact product of at least one solid oxide compound, at least one electron-withdrawing anion source compound, and optionally, at least one metal salt compound;

wherein the organometal compound has the following general formula:



wherein M^1 is selected from titanium, zirconium, or hafnium;

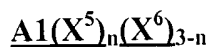
wherein (X^1) and (X^2) are independently selected from cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, or substituted fluorenyls;

wherein substituents on the substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X^1) and (X^2) are selected from aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, or hydrogen;

wherein at least one substituent on (X^1) and (X^2) is a bridging group which connects (X^1) and (X^2) ;

wherein (X^3) and (X^4) are independently selected from halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxy groups, substituted alkyloxy groups, aryloxy groups, substituted aryloxy groups, organometallic groups, or substituted organometallic groups; and

wherein the organoaluminum compound has the following general formula:



wherein (X⁵) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X⁶) is a halide, hydride, or alkoxide; and

wherein "n" is a number from 1 to 3 inclusive.

16. (Currently Amended) A catalyst composition ~~produced by the process of claim 12~~ comprising a contact product of a catalyst precursor; at least one organometal compound selected from rac-dimethylsilybis (1-indenyl) zirconium dichloride, rac-1,2-ethanediylbis(1-indenyl)zirconium dichloride, or rac-dimethylsilybis (2-methyl-1-indenyl) zirconium dichloride; and at least one organoaluminum compound selected from triethylaluminum or triisobutylaluminum, the catalyst precursor comprising a chlorided, zinc-containing alumina and propylene.

17. (Currently Amended) A catalyst composition ~~produced by the process of Claim 13~~ comprising a contact product of at least one treated solid oxide compound, at least one organometal compound, at least one organoaluminum compound, and at least one alpha olefin;

wherein the at least one treated solid oxide compound comprises a contact product of at least one calcined solid oxide compound, at least one electron-withdrawing anion source compound, and optionally, at least one metal salt compound;

wherein the organometal compound has the following general formula:



wherein M¹ is selected from titanium, zirconium, or hafnium;

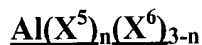
wherein (X¹) and (X²) are independently selected from cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, or substituted fluorenyls;

wherein substituents on the substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X¹) and (X²) are selected from aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, or hydrogen;

wherein at least one substituent on (X¹) and (X²) is a bridging group which connects (X¹) and (X²);

wherein (X³) and (X⁴) are independently selected from halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxide groups, substituted alkyloxide groups, aryloxide groups, substituted aryloxide groups, organometallic groups, or substituted organometallic groups; and

wherein the organoaluminum compound has the following general formula:



wherein (X⁵) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X⁶) is a halide, hydride, or alkoxide; and

wherein "n" is a number from 1 to 3 inclusive.

18. (Currently Amended) A catalyst composition ~~produced by the process of Claim 14~~ comprising a contact product of a chlorided, zinc-containing alumina; propylene; at least one organometal compound selected from rac-dimethylsilybis (1-indenyl) zirconium dichloride, rac-1,2-ethanediylbis (1-indenyl) zirconium dichloride, or rac-dimethylsilybis (2-methyl-1-indenyl) zirconium dichloride; and at least one organoaluminum compound selected from triethylaluminum and triisobutylaluminum.

19. (Currently Amended) A The catalyst composition according to ~~claim~~ Claim 15, wherein ~~said the~~ the catalyst composition has an activity greater than 500 grams of polypropylene per gram of treated solid oxide compound per hour under slurry polymerization conditions, using liquid propylene as a diluent, with a polymerization temperature of 70°C.

20. (Currently Amended) A The catalyst composition according to ~~claim~~ Claim 19, wherein ~~said the~~ the catalyst composition has an activity greater than 1000 grams of polypropylene per gram of treated solid oxide compound per hour under slurry polymerization conditions, using liquid propylene as a diluent, with a polymerization temperature of 70°C.

21. (Currently Amended) A The catalyst composition according to Claim 15, wherein a weight ratio of ~~said the~~ the organoaluminum compound to ~~said the~~ the treated solid oxide compound in ~~said the~~ the catalyst composition ranges from about 3:1 to about 1:100.

22. (Currently Amended) A The catalyst composition according to Claim 21, wherein said the weight ratio of said the organoaluminum compound to said the treated solid oxide compound in said the catalyst composition ranges from 1:1 to 1:50.

23. (Currently Amended) A The catalyst composition according to Claim 15, wherein a weight ratio of said the treated solid oxide compound to said the organometal compound in said the catalyst composition ranges from about 1000:1 to about 10:1.

24. (Currently Amended) A The catalyst composition according to Claim 23, wherein said weight ratio of said the treated solid oxide compound to said the organometal compound in said the catalyst composition ranges from 250:1 to 20:1.

25. (Currently Amended) A The catalyst composition according to ~~claim~~ Claim 17, wherein said the catalyst composition has an activity greater than 500 grams of polypropylene per gram of treated solid oxide compound per hour under slurry polymerization conditions, using liquid propylene as a diluent, with a polymerization temperature of 70°C.

26. (Currently Amended) A The catalyst composition according to ~~claim~~ Claim 25, wherein said the catalyst composition has an activity greater than 1000 grams of polypropylene per gram of treated solid oxide compound per hour under slurry polymerization conditions, using liquid propylene as a diluent, with a polymerization temperature of 70°C.

27. (Currently Amended) A The catalyst composition according to Claim 17, wherein a weight ratio of ~~said~~ the organoaluminum compound to ~~said~~ the treated solid oxide compound in ~~said~~ the catalyst composition ranges from about 3:1 to about 1:100.

28. (Currently Amended) A The catalyst composition according to Claim 27, wherein ~~said~~ the weight ratio of ~~said~~ the organoaluminum compound to ~~said~~ the treated solid oxide compound in ~~said~~ the catalyst composition ranges from 1:1 to 1:50.

29. (Currently Amended) A The catalyst composition according to Claim 17, wherein a weight ratio of ~~said~~ the treated solid oxide compound to ~~said~~ the organometal compound in ~~said~~ the catalyst composition ranges from about 1000:1 to about 10:1.

30. (Currently Amended) A The catalyst composition according to Claim 29, wherein ~~said~~ the weight ratio of ~~said~~ the treated solid oxide compound to ~~said~~ the organometal compound in ~~said~~ the catalyst composition ranges from 250:1 to 20:1.

31. (Currently Amended) A polymerization process comprising contacting ~~said~~ the catalyst composition of Claim 15 and additional alpha olefin in a polymerization zone under polymerization conditions to produce a polymer.

32. (Currently Amended) A The process according to Claim 31, wherein ~~said~~ the additional alpha olefin is propylene.

33. (Currently Amended) A The process according to Claim 31, wherein ~~said~~ the additional alpha olefin is propylene and ethylene.

34. (Currently Amended) A The process according to Claim 31, wherein ~~said~~ the polymerization conditions comprise slurry polymerization conditions.

35. (Currently Amended) A The process according to ~~claim~~ Claim 34, wherein ~~said~~ the contacting is conducted in a loop reaction zone.

36. (Currently Amended) A The process according to ~~claim~~ Claim 35, wherein ~~said~~ the contacting is conducted in the presence of a diluent that comprises, in major part, propylene.

37. (Currently Amended) A polymerization process comprising contacting ~~said~~ the catalyst composition of Claim 17 and additional alpha olefin in a polymerization zone under polymerization conditions to produce a polymer.

38. (Currently Amended) A The process according to Claim 37, wherein ~~said~~ the additional alpha olefin is propylene.

39. (Currently Amended) A The process according to Claim 37, wherein ~~said~~ the additional alpha olefin is propylene and ethylene.

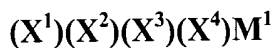
40. (Currently Amended) A The process according to Claim 37, wherein ~~said~~ the polymerization conditions comprise slurry polymerization conditions.

41. (Currently Amended) A The process according to ~~claim~~ Claim 40, wherein ~~said~~ the contacting is conducted in a loop reaction zone.

42. (Currently Amended) A ~~The~~ process according to ~~claim~~ Claim 41, wherein ~~said~~ the contacting is conducted in the presence of a diluent that comprises, in major part, propylene.

43. (Currently Amended) A process to produce a polymer, ~~said process~~ comprising substantially simultaneously contacting at least one organometal compound, at least one organoaluminum compound, at least one treated solid oxide compound, and at least one alpha olefin under polymerization conditions to produce ~~said~~ the polymer;

wherein ~~said~~ the organometal compound has the following general formula:



wherein M^1 is selected from ~~the group consisting of~~ titanium, zirconium, ~~and~~ or hafnium;

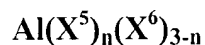
wherein (X^1) and (X^2) are independently selected from ~~the group consisting of~~ cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, ~~and~~ or substituted fluorenyls;

wherein substituents on ~~said~~ the substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X^1) and (X^2) are selected from ~~the group consisting of~~ aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, ~~and~~ or hydrogen;

wherein at least one substituent on (X^1) and (X^2) is a bridging group which connects (X^1) and (X^2) ;

wherein (X³) and (X⁴) are independently selected from ~~the group consisting of~~ halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxy groups, substituted alkyloxy groups, aryloxy groups, substituted aryloxy groups, organometallic groups, ~~and~~ or substituted organometallic groups; and

wherein ~~said~~ the organoaluminum compound has the following general formula:



wherein (X⁵) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X⁶) is a halide, hydride, or alkoxide;

wherein "n" is a number from 1 to 3 inclusive; and

wherein ~~said~~ the treated solid oxide compound is produced by a process comprising: a) contacting at least one solid oxide compound with at least one electron-withdrawing anion source compound; b) optionally, also contacting ~~said~~ the solid oxide compound with at least one metal salt compound; and c) calcining ~~said~~ the solid oxide compound before, during, or after contacting ~~said~~ the electron-withdrawing anion source compound or ~~said~~ the metal salt compound to produce ~~said~~ the treated solid oxide compound.

44. (Currently Amended) A The process according to Claim 43, wherein ~~said the~~ at least one alpha olefin is propylene.

45. (Currently Amended) A The process according to Claim 43, wherein ~~said the~~ at least one alpha olefin is propylene and ethylene.

46 – 48 (Canceled).

49. (New) The process in accordance with Claim 11, wherein the at least one treated solid oxide compound comprises a calcined contact product of at least one solid oxide compound, at least one electron-withdrawing anion source compound, and optionally, at least one metal salt compound.

50. (New) The process in accordance with Claim 11, wherein the at least one solid oxide compound comprises at least one calcined solid oxide compound.

51. (New) A process to produce a catalyst composition comprising:

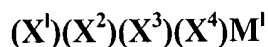
1) contacting a catalyst precursor with at least one organometal compound and at least one organoaluminum compound;

wherein the catalyst precursor comprises at least one treated solid oxide compound and at least one alpha olefin;

wherein the treated solid oxide compound is produced by a process comprising: a) contacting at least one solid oxide compound with at least one electron-withdrawing anion source compound; b) optionally, also contacting the solid oxide compound with at least one metal salt compound; and c) calcining the solid oxide compound

before, during, or after contacting the electron-withdrawing anion source compound or the metal salt compound to produce the treated solid oxide compound;

wherein the organometal compound has the following general formula:



wherein M^1 is selected from titanium, zirconium, or hafnium;

wherein (X^1) and (X^2) are independently selected from cyclopentadienyls, indenyls, fluorenyls, substituted cyclopentadienyls, substituted indenyls, and or substituted fluorenyls;

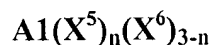
wherein substituents on the substituted cyclopentadienyls, substituted indenyls, and substituted fluorenyls of (X^1) and (X^2) are selected from aliphatic groups, cyclic groups, combinations of aliphatic and cyclic groups, silyl groups, alkyl halide groups, halides, organometallic groups, phosphorus groups, nitrogen groups, silicon, phosphorus, boron, germanium, or hydrogen;

wherein at least one substituent on (X^1) and (X^2) is a bridging group which connects (X^1) and (X^2) ;

wherein (X^3) and (X^4) are independently selected from halides, aliphatic groups, substituted aliphatic groups, cyclic groups, substituted cyclic groups, combinations of aliphatic groups and cyclic groups, combinations of substituted aliphatic groups and cyclic groups, combinations of aliphatic groups and substituted cyclic groups, combinations of substituted aliphatic groups and substituted cyclic groups, amido groups, substituted amido groups, phosphido groups, substituted phosphido groups, alkyloxy groups, substituted

alkyloxy groups, aryloxy groups, substituted aryloxy groups, organometallic groups, or substituted organometallic groups; and

wherein the organoaluminum compound has the following general formula:



wherein (X^5) is a hydrocarbyl having from 1-20 carbon atoms;

wherein (X^6) is a halide, hydride, or alkoxide; and

wherein "n" is a number from 1 to 3 inclusive.

52. (New) The catalyst composition in accordance with Claim 15, wherein the at least one treated solid oxide compound comprises a calcined contact product of at least one solid oxide compound, at least one electron-withdrawing anion source compound, and optionally, at least one metal salt compound.

53. (New) The catalyst composition in accordance with Claim 15, wherein the at least one solid oxide compound comprises at least one calcined solid oxide compound.

54. (New) A process to produce a polymer comprising contacting the catalyst composition of Claim 51 and additional alpha olefin in a polymerization zone under polymerization conditions to produce a polymer.

55. (New) The process according to Claim 54, wherein the additional alpha olefin is propylene.

56. (New) The process according to Claim 54, wherein the additional alpha olefin is propylene and ethylene.

57. (New) The process according to Claim 54, wherein the polymerization conditions comprise slurry polymerization conditions.

58. (New) The process according to Claim 54, wherein ~~said~~ the contacting is conducted in a loop reaction zone.

59. (New) The process according to Claim 54, wherein the contacting is conducted in the presence of a diluent that comprises, in major part, propylene.